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This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

☒ This application has been examined ☒ Responsive to communication filed on 6/22/94 ☐ This action is made final.

A shortened statutory period for response to this action is set to expire three (3) month(s), ~~0 days from~~ the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☒ Notice of References Cited by Examiner, PTO-892.
2. ☒ Notice of Draftsman's Patent Drawing Review, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474..
6. ☐ _____.

Part II SUMMARY OF ACTION

1. ☒ Claims 45-180 are pending in the application.
   Of the above, claims _____ are withdrawn from consideration.
2. ☒ Claims 1-44 have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☒ Claims 45-180 are rejected.
5. ☐ Claims _____ are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☐ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable; ☐ not acceptable (see explanation or Notice of Draftsman's Patent Drawing Review, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____. has (have) been ☐ approved by the examiner; ☐ disapproved by the examiner (see explanation).
11. ☐ The proposed drawing correction, filed _____, has been ☐ approved; ☐ disapproved (see explanation).
12. ☐ Acknowledgement is made of the claim for priority under 35 U.S.C. 119. The certified copy has ☐ been received ☐ not been received ☐ been filed in parent application, serial no. _____; filed on _____.
13. ☐ Since this application apppears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

EXAMINER'S ACTION

PTOL-326 (Rev. 2/93)

Claims 45-180 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 45, line 6, it is unclear what "predominantly" modifies. If it modifies "recovering", it is unclear what "recovery predominantly" means.

In claim 45, line 8, and in claim 83, line 8, it is unclear whether "recovering C_{60} from said... product" requires any degree of separation of C_{60} from the "sooty product", or any level of C_{60} content or purity. Similarly, in claim 114, line 9 and in claim 118, line 13, and in claim 119, lines 9-10, and in claim 124, lines 10-11, and in claim 125, lines 13-14, and in claim 126, lines 11-12, and claim 127, lines 15-16 and claim 131, lines 11-12, and in claim 132, line 10, and in claim 133, lines 14-15, and in claim 134, line 15, and in claim 154, lines 1-2, and in claim 160, last two lines, it is unclear whether "recovering" the material of the respective claims, preamble requires any degree of separation of "caged molecules" or "carbon allotrope" or "soluble carbon product" from the "sooty product", or any level of "caged molecule" or "carbon allotrope" or "soluble carbon product" content or purity.

In claim 45, line 7, and in claim 138, lines 7-11, it is unclear as to how much constitutes "amounts... capable of

extracting and recovering... therefrom said C_{60} in solid form". For example, if, arguendo, a microgram of C_{60} was an amount needed to qualify as solid C_{60}, would a process which produced a kilogram of soot which in toto contained microgram C_{60} (i.e., a parts-per-billion concentration) be within the claims (since 1 μg C_{60} is "capable" of being extracted and "capable" of yielding 1 μg solid C_{60})? Does the claimed process depend upon what scale it is run, i.e., how much "sooty carbon product" is made or collected, or whether the process is batch or continuous? Similarly, in claim 114, lines 6-8, and in claim 118, lines 6-8, and in claim 139, lines 8-11, and in claim 160, lines 9-12, it is unclear as to how much "caged molecule" constitutes "amounts... capable of extracting and recovering therefrom said caged molecules in solid form". Similarly, in claim 126, lines 7-10, and in claim 127, lines 7-10, and in claim 140, lines 9-11, it is unclear as to how much "carbon allotrope" constitutes "quantities... capable of extracting and recovering therefrom said allotrope in solid form". Also, in claim 131, lines 7-9, and claim 133, lines 7-9, and claim 141, lines 9-12, it is unclear how much "soluble carbon product" is "sufficient quantities in said sooty carbon product to be capable of extracting and recovering therefrom said soluble carbon product in solid form".

The lower limit as to the scope of the claimed "amounts" is

indefinite.

In claim 50, line 9, and in claim 84, line 12, and in claim 93, line 7, it is unclear what is the scope of "predominantly C_{60}". Would a product containing 2 wt% C_{60} and 98 other species each at 1 wt% be a product which is "predominantly C_{60}"? Similarly, in claim 120, lines 13-14, it is unclear what is the scope of "predominantly... caged molecules".

In claim 55, it is unclear whether the product which is recovered in claim 50, step (d) must be crystalline, or whether it can be amorphous but contain crystalline C_{60}.

In claims 58 and 89, it is unclear whether the recovery of C_{70} from the sooty carbon product requires any particular degree of separation of C_{60} from the sooty carbon product.

In claims 62-64, there is no literal antecedent for "the recovering step".

In claim 65, there is no literal antecedent for "the depositing step".

In claims 66, 97, 150, and 171, it is unclear how a chamber can be "evacuated" and yet simultaneously contain therein "an inert quenching gas", given "evacuated" a normal dictionary definition of "in a vacuum".

In claim 83, lines 4-7, and in claim 84, lines 5-7, and in claim 119, lines 6-9, and in claim 120, lines 6-8, and in claim 124, lines 6-9 and claim 125, lines 6-8, and in claim 132, lines

7-9, and in claim 134, lines 8-10, and in claim 142, lines 7-10, and in claim 143, lines 8-12, and in claim 144, lines 9-12, and in claim 145, lines 9-12, it is initially unclear how a practitioner of the process can know with certainty whether said practitioner has in possession "amounts sufficient to be capable of providing a ...colored solution", as detection of "colored" depends upon visual acuity, which varies from person to person.

In claim 83, lines 4-7, and in claim 84, lines 5-7, and in claim 119, lines 6-9, and in claim 120, lines 6-8, and in claim 124, lines 6-9 and claim 125, lines 6-8, and in claim 132, lines 7-9, and in claim 134, lines 8-10, and in claim 142, lines 7-10, and in claim 143, lines 8-12, and in claim 144, lines 9-12, and in claim 145, lines 9-12, it is unclear as to what is the scope of "amounts [or quantities] [of C_{60}] sufficient to be capable of producing a... colored solution when extracted with sufficient [or effective] amounts of benzene". Would a metric ton of "sooty carbon product" containing a gram of C_{60} (i.e., a ppm C_{60} concentration) and extracted with a liter of solvent, be within the scope of the claims, (since quantities on the order of one gram C_{60} can impart color to solvent quantities on the order of one liter)? Note that the breadth of "extracted" does not preclude portionwise Soxhlet extraction of large quantities of "sooty carbon product" (e.g., metric ton) with small quantities of solvent (e.g., liter). What then is the lower limit of the

scope of the claims as to amount of C_{60}?

In claim 85, line 2, it is unclear as to how much C_{60} is an amount "sufficient to form a solid". What "solid" is being referred to? How would the claim differ from any solid material which contains trace C_{60} (since C_{60} would in that case not have prevented the material from being in the solid state)? If the claim intends to be interpreted as "amounts sufficient to form [a] solid $\underline{C}_{60}$", it would be further unclear as to what the lower limit of those "amounts" would be: how much of anything is the accepted value to be considered a "solid"? Note that a solid particle of colloidal gold can be 1.7×10^{-7} cm in size. Is this the order of magnitude which Applicants intend?

In claim 85, line 2, and in claim 86, line 1, and in claim 87, line 1, it is unclear what is the antecedent for "the C_{60}". Does it refer back to the state of the C_{60} as it is present in the soot, or to the C_{60} within the "product which is predominantly C_{60}"?

In claim 110, there is no antecedent for "the solid C_{60}".

In claims 114, 118, 119, 120 and 160, it is unclear what is a "caged molecule". Is it a molecules such as carbon dioxide within clathrates of hydrogen-bonded water molecules)?

The following is a quotation of the first paragraph of 35 U.S.C. § 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using

> it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification is objected to under 35 U.S.C. § 112, first paragraph: as the specification, as originally filed, does not adequately describe or support the invention as is now claimed; and as failing to adequately teach how to make and/or use the invention, i.e., failing to provide a disclosure which enables the person skilled in the art to which the instantly claimed invention pertains, to make and use an invention commensurate in scope with the claims.

Claims 114, 118, 119, 120, 124, 125 recite "preparing caged molecules consisting solely of carbon atoms" made in "sufficient amounts to be capable of extracting and recovering... said caged molecules as a solid", or "preparing a carbon allotrope... capable of being dissolved in non-polar solvents and said carbon allotrope being present in amounts sufficient to be capable of producing a visibly colored solution...". However, the specification or originally filed has no written description of "caged molecules"; it merely characterizes that C_{60} and C_{70} can be deemed species of "caged molecules". The specification as originally filed had no written description of a genus of "carbon allotrope", only of a "brownish-red allotrope of carbon" or that C_{60}/C_{70} is an allotrope of carbon. However, two species do not

ordinarily support a genus. "Caged molecules" (to the extent the phrase is understood) and "carbon allotrope... capable of being dissolved in non-polar solvents" appears to encompass carbon nanotubes (open and closed), and species such as C_{76}, C_{80}, C_{82}, etc., for which there is no written description in the original disclosure. Since the disclosure does not reasonably convey to one of ordinary skill in the pertinent art that the applicants had possession of what is now claimed, at the time the application was filed, the claims introduce new concepts and thus contain new matter.

Furthermore, the disclosure does not enable the person skilled in the art to which the instantly claimed invention pertains, to make and use an invention commensurate in scope with the claims, since the specification is not enabled for the preparation of "caged molecules" or "carbon allotrope" in the amounts specified in claims 114, 118, 119, 120 and 124. The claim embraces the production of tonnage quantities of open or closed carbon nanotubes or C_{76} or C_{80}, etc. Yet, page 8, lines 1-5 recites, in characterizing Applicants' product, that "the only other large mass found in any abundance corresponds to C_{70}". Thus even if arguendo the instant disclosure teaches one to make and use trace quantities of open or closed carbon nanotubes or C_{76} or C_{80}, etc., it clearly does not enable one to make those species in "any abundance".

The specification is also not a commensurately enabling one, because the scope of the claims is broadened from the original disclosure, in that they now embrace formation an isolation of very large quantities of C_{60} (e.g., one ton), while the original disclosure's literal language only supports the production of $C_{60/70}$ quantities sufficient to produce coatings that are 2 microns thick. There is no disclosure supporting or describing larger quantities of C_{60} as are now embraced by the claims.

Claims 45-180 are rejected under 35 U.S.C. § 112, first paragraph, for the reasons set forth in the objection to the specification.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which

> the invention was made.
> Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

Evaluations of the level of ordinary skill in the art requires consideration of such factors as various prior art approaches, types of problems encountered in the art, rapidity with which innovations are made, sophistication of technology involved, educational background of those actively working in the field, commercial success, and failure of others.

The "person having ordinary skill" in this art has the capability of understanding the scientific and engineering principles applicable to the claimed invention. The evidence of record including the references and/or the admissions are considered to reasonably reflect this level of skill.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. § 103, the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 C.F.R. § 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of potential 35 U.S.C. § 102(f) or (g) prior art under 35 U.S.C. § 103.

Claims 45-46, 50-51, 55-58, 66, 68-71, 73-74, 83-87, 89, 97, 99-102, 104-105, 114-115, 118-121, 124-128, 131-135, 138-150, 152-154, 158, 160-168, 171-175, and 177-178 are rejected under 35 U.S.C. § 102(b) as being anticipated by the Huffman article entitled "Measured Extinction efficiency of Graphite Smoke..."; with the Iijima article (Journal of Phys. Chem.) cited to show inherent states of fact.

Huffman teaches vaporizing carbon from graphite electrodes

through which an arc is struck under a pressure of helium gas. A smoke cloud was collected on a substrate held a short distance from the arc. The helium gas inherently acts as a quench gas as it is the same gas used in the same vaporization reaction as that recited in the instant claims (see e.g., claim 74).

See page 50, col. 1, line 39 to col. 2, line 9 of the reference.

The Iijima reference teaches that inherently C60 fullerene is formed in a method in which carbon is evaporated by arc discharge. See page 3466, col. 1, last paragraph. Electron micrographs show a spherical particle of graphite carbon containing the 60-carbon cluster (i.e.; C_{60} fullerene). See Figure 1a. The cluster appears to be contained within a carbon film formed as a result of the arc discharge, under vacuum.

Thus, because Iijima shows that C_{60} is formed as a part of a film resulting from arc discharge between carbon rods even under vacuum, then the arc vaporization of the Huffman reference would inherently form at least as much or more C_{60} since it utilizes an inert quenching gas. The limitation of "recovering C_{60}" is met, to the extent it is understood, because C_{60} is clearly formed, and the limitation specifies no extent of separation. The C_{60} is in solid form since the coatings in Huffman are solid. The limitation in claim 50 that a product which is "predominantly C_{60}" is recovered is met because Huffman shows step (a) and (b)

of claim 50 as discussed above, as well as step (c) (particles collected on the substrate were studied by electron microscope), then if the claim is considered to be complete (i.e., set forth every necessary step), Huffman must inherently also recover "a product which is predominantly C_{60} from said sooty carbon product", since the process steps are the same.

Alternatively, note that claim 56/45 shows two steps: (a) vaporizing a carbon source under helium quenching gas "under conditions effective to form... C_{60} molecules... in amounts capable of extracting and recovering predominantly therefrom said C_{60} in solid form", followed very simply by (b) recovering substantially pure solid C_{60}. Step(a) of claim 56/45 is sufficiently broad and/or indefinite to embrace C_{60} formation in amounts equivalent to one colloidal solid particle of carbon. Iijima shows that spherical particles of graphitized carbon of sizes up to 70 angstroms are inherently made in Huffman's process. (See page 3466, col. 1, lines 18-22). Thus, Huffman makes C_{60} in the amount required by claim 56/45. Huffman must also inherently make substantially pure solid C_{60}, since the only named step of claim 56 is met. Identical steps result in identical products.

It is noted for emphasis that should Applicants argue that the art which meets the steps is not enabled for the recovery of substantially pure C_{60}, or a product which is predominantly C_{60},

then likewise would claims having the same steps be considered not enabled.

Claims 45-180 are rejected under 35 U.S.C. § 103 as being unpatentable over Huffman article entitled, "Measured Extinction Efficiency of Graphite Smoke...", in view of Iijima, and Soviet Patent 000.

Application of the Huffman article and Iijima are as above.

To the extent that the Huffman reference may not identically disclose process conditions of pressure falling within the scope of Applicants' functionally claimed steps, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have evaporated carbon via arc discharge under a helium quenching atmosphere because Huffman shows such a process, and Iijima teaches that one would expect C_{60} fullerene to be formed in Huffman's process, and because pressure has been held to be an art recognized, result-effective variable for which it is obvious to find the best value by optimization: See In re Aller, et al. 105 USPQ 233.

Note that the parameter of "pressure" was chosen in the above formulation of the rejection because it is the only parameter which is disclosed in the specification as affecting quantities of fullerene present in the soot. See page 4, lines 16-25 and page 6, lines 8-10. It does not appear that choice of carbon, or carbon heating method, or voltage, or amperage, or

type of current, or type of reactor, is disclosed as being critical with respect to quantity of fullerene formed. Should Applicants advance the argument that the references would not enable one to attain whatever the quantity of fullerene the claims require due to the absence of a teaching of some other parameter, note that the instant disclosure also lacks disclosure of a parameter other than pressure which is critical with respect to quantity of fullerene formed.

With respect to claims requiring recovering C_{60} fullerene in a non-polar benzene or toluene solution, note that the Soviet patent teaches extraction of C_{60} and C_{70} compounds from a crude source by toluene and separation of C_{60} from C_{70} by chromatography. See entire document. After extraction, the product dissolved therein is weighed. While it is noted that the reference recovers derivatives of C_{60} such as $C_{60}La$, it would have been obvious to one of ordinary skill in the art to use the solvent disclosed in the reference to extract underivatized C_{60} because the substraction of a single La atom from a molecule having 60 carbon atoms in such a structured arrangement would not be expected to drastically alter the solubility properties of the compound.

With respect to sublimation, note that it is well known to sublime organic-soluble species to purify them, and official notice is taken of same. Since the prior art shows organic

solubility to be a characteristic of fullerenes, it would have been obvious to one of ordinary skill in the art to sublime fullerene from either the as-recovered sooty carbon product or the toluene-extracted material of the combined references' process because it is well known to sublime organic-soluble species in order to purify them.

With regards to the "about 100" ampere limitation, note that this value is taught in Iijima as being operable for fullerene formation, and it would have been obvious to run the Huffman process at that current in order to evaporate carbon to form a carbon coat.

With respect to the "bell jar carbon evaporator" limitation, not that this appears to be a conventional apparatus element. With respect to the limitation as to "glass" substrate, note that Huffman shows a silica substrate, which appears to reasonably suggest the limitation because glass is principally comprised of silica. With respect to the distance of he substrate from the vaporization source, note that while what is claimed is not identically disclosed in Huffman, it would have been obvious to determine the optimum distance because, Huffman is directed to collecting particulate soot on the substrate and distance would be an obvious parameter to optimize.

Claims 45-46, (68-71)/45, (73-74)/45, 83,85, (99-102)/83, (104-105)/83, 114-115, 118-121, 124, 126, 128/124, 131-135, 138-

149, 152-154, 158, 160-163, (167-168)/163, 172-175, 177-178 are rejected under 35 U.S.C. § 102(b) as being anticipated by Bacon (US Patent 2,957,756).

Bacon strikes an arc from a graphite rod to a graphite block, all under an argon atmosphere of 1360 pounds per square inch, using 80 VOLTS direct current, 60 amperes per square inch. What was isolated were carbon filaments of crystal perfection approaching that of single crystals. See col. 2, lines 18-60. The conditions performed in Bacon were the same as those which the instant specification states are effective to form C_{60} fullerene ("the pressure can be raised to any level just below the point where the reactor would explode"; page 4, line 31- page 5, line 1), therefore Bacon must have inherently made C_{60} fullerene to the same extent as in the rejected claims. Whatever C_{60} was made was solid after cooling.

Bacon also most distinctly meets the limitations of claims 114 and 118, because "caged molecules consisting solely of carbon atoms", as written, is sufficiently broad to embrace the "large graphite sheets rolled up into a tight tube" explicitly formed by Bacon (col. 3, lines 15-20).

Claims 45-46, 50-51, 58, 66, 68-75, 83-85, 89, 97, 99, 100-106, 114-115, 118-121, 124-128, 131-150, 152-155, 158-163, 171-178 are rejected under 35 U.S.C. § 102(b) as being anticipated by Kappler article entitled "Fine Carbon Particle Formation by

Carbon-Vapor Condensation".

Kappler produces carbon vapor by electrically heating graphite rods at 100-110 amperes under at atmosphere of 30 torr argon. Pyrex glass substrates at 4cm distance from the evaporation collects aggregates of particulate carbon deposits. See pg. 308, col. 2, lines 18-38, pg 309, col. 2, last 5 lines and pg. 310, col. 1.

Kappler inherently produces C_{60} fullerene in the amounts claimed because it evaporates the same graphite rods through which is run the same current under the same inert atmosphere and collects carbon particles on the same substrate at the same distance from the vaporization, as in the instantly rejected claims. The obtention of the carbon deposit per se qualifies as the C_{60} recovery of claim 45 (since no separation is required), and the substantially pure C_{60} limitation of claims 50-51 is inherently met because the positive process steps are the same.

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Diefendorf (US 3,172,774) teaches decomposing methane via inductive heating to 2000°C and 350 torr, into carbon vapor which condenses to form soot. The reference states that "the soot particle is probably formed by the growth of a large carbon molecule which upon reaching a critical size is coated around its periphery with smaller aromatic molecules" (col. 3, lines 24-33).

Reck teaches extracting substances from out of "carbon blacks obtained by the arc process", by means of contact with toluene. See col. 1, lines 30-33 of US Patent 4,435,378.

Any inquiry concerning this communication should be directed to Peter DiMauro at telephone number (703) 308-0680.

DiMauro/mmm
December 16, 1994

Michael Lewis
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